МОДЕЛИ, МЕТОДЫ, АЛГОРИТМЫ И ПРОГРАММНЫЕ СРЕДСТВА В ЭКОНОМИКЕ И ПРИРОДОПОЛЬЗОВАНИИ

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IMPACT OF ENERGY ON THE ENVIRONMENT THE CASE OF JAPAN

Abstract:
The purpose of this paper is to examine how energy resources affect Japan's environment, using data over a period from 2000 to 2014. Today, prevention of environmental pollution and conservation of environment have a dimension exceeding national borders. The risks that result from using of fossil fuels increasingly (petroleum, coal, and gas) must be decreased. To decrease such risks, besides to increasing of energy productivity, energy resources that emit less greenhouse gases in the atmosphere (like Carbon-dioxide (CO2)) must be preferred. To examine the impact of energy on the Japan's environment, a linear function was used to develop a model using carbon dioxide (CO2) emission and total energy consumption of Japan. CO2 is the dependent variable and energy consumption as the independent variable. A regression analysis was run on the model to know the relationship between these variables. The empirical results showed a positive relationship between CO2 and energy consumption. The result also showed Japan is highly reliable on non-renewable energy resources such as fossil fuels for its energy needs and these non-renewable energy resources have greater impact on the environment.

Keywords:
Energy, environment, renewable energy, non-renewable energy, Japan.

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1. Introduction

Energy is one of the most important elements that satisfy the essential needs of modern life. This makes energy a crucial sector that other sectors of the economy rely on. Energy consumption has always been on the rise and it's predicted to be continuously rising due to the high demand of energy. However, during the last two decades, energy production and consumption impacts on the environment are have been one of the major issues facing the world, as energy production and consumption are the leading contributor to greenhouse gases which lead to global warming and climate change.

Energy is the power derived from the utilization of physical or chemical resources, especially to generate light and heat or to work. Energy resources in the world can be categorized as fossil fuel, nuclear fuel and renewable energy. Renewable energy is energy from natural source that replenish itself. Examples are wind and solar power. Fossil fuel and nuclear fuel are non-renewable energy, thus, energy that cannot be readily replaced by natural means.

Japan is country with population of about 127 million. According to the International Monetary Fund (IMF) world economic outlook (April, 2016), Japan has a nominal GDP of 4,412.600 billion (USD) with GDP per capita of 32, 484 (USD). They were ranked the third largest economy in the world. Japan is one of the leading automobile manufacturing countries in the world and has the largest electronic goods industry. Their main industries are motor vehicles, electronic equipment, machine tools, steel and nonferrous metals, ships, chemicals, textiles and processed foods. Services sector contributes 71.4% to their GDP, followed by the industry sector which contributes 27.5% and finally by agriculture sector that accounts for 1.2% to GDP. Their main export goods are motor vehicles, semiconductors, iron and steel products, auto parts, plastic materials and power generating machinery. Their main import goods are petroleum, liquid natural gas, clothing, coal, audio and visual apparatus. This shows how Japan really rely on importation for their energy needs because their main import goods are mainly energy resources.

The main reason for carrying out this research is to find out how energy affect Japan's environment. Moreover, pollution and global warming is one of the major problems facing the world and economic policy makers. Energy production and consumption are one of the major sources of carbon dioxide emissions, therefore, economic and energy policy makers are in a state of confusion whether a decrease in energy production and consumption will reduce economic growth. Hence, there is the need to analyze this scenario.

2. Data and the Model

Data used in this analysis are carbon dioxide emission and total energy consumption from International Energy Agency and the Bank of Japan. The time period for this analysis is 2000-2014.

I analyzed the relationship between CO2 and total energy consumption to know the impact of energy on the environment. The model used CO2 and total energy consumption, with CO2 as the dependent model and total energy consumption as independent variable. The linear function for the model is;

$$CO2 = a + \alpha C$$

Where,
CO2 = Carbon Dioxide
C = Total Energy Consumption
a = Constant
α is a constant between 0 and 1

3. Empirical Results and Discussion

A regression analysis was run on the model using R statistical software. Table 1 below shows the result of the regression analysis on the model.

Table 1

Regression Analysis for the Model

Model	**B**	**Std. Error**	**t-value**	**Sig. value**
Intercept	4.622	2.32	1.992	0.0678
TEC	0.0086649	0.0151873	2.099	0.0559

Dependent Variable: CO2

Residuals

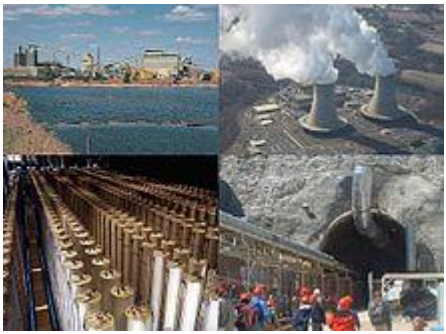
Min	1Q	Median	3Q	Max	R^2	Adjusted R^2	P-value
-0.65457	-0.20098	-0.01846	0.27431	0.41610	0.2531	0.1957	0.05591

3.1 Discussion for the Model

The regression result for this model showed a positive relationship between carbon dioxide emission and energy consumption with α = 0.0086649. Though, Japan is using energy efficient products currently, but CO2 emissions is still a major issue facing the country. Energy consumption by the country's businesses, households, agricultural and industrial activities contribute to a broad range of environmental issues through the emissions of greenhouse gases or CO2 by these sectors of the economy. A major environmental issue facing Japan today is dealing with the aftermath of the Fukushima nuclear power plant disaster. The disaster happened in 2011, but it continues to have a major environmental effect in Japan. It was unveiled that radioactive water from the destroyed plant is leaking into the ocean. Non-renewable energy is known to be emitting more greenhouse gases into the atmosphere than renewable energy resources. The environmental impact caused by energy includes, air pollution, water pollution, damage to public health,

wildlife and habitat loss, global warming and climate change. However, the impact of each energy resource is discussed below.

3.1.1 Non-renewable Energy Effects on the Environment



Nuclear Power

Japan maintains one third of its electric production from nuclear power plants. Majority of Japanese were in support of their dependency on nuclear energy, however, after the Fukushima nuclear accident in March, 2011, this support shifted to majority demanding a total switch from nuclear energy to other clean and safe renewable energy. This change of support was due to the environmental hazard caused by the nuclear power plant after the accident. Nuclear power has three waste streams that affect the environment. These includes, spent nuclear fuel at the rector site (including fission products and plutonium waste), tailings and waste rock at uranium mining mills during rector operations and large quantities of radioactive materials released during accidents. Nuclear power plants release gaseous and liquid radiological effluents into the environment as by-product of production. These radiation or greenhouse gas emissions into the atmosphere are the leading causes of global warming and climate change in Japan and the world at large. Moreover, uranium mining and milling have great dangers to the environment. Uranium is use as a fuel for nuclear power plant. Uranium production can use large amount of water and also the in-situ leaching production method uses solutions to dissolve the uranium. When in taking water for cooling, nuclear plants use special structures. Water is often drawn through screens to minimize to entry of debris. The problem is that many aquatic organisms are trapped and killed against the screens, through a process known as impingement. Thus, many marine organisms die as a result of nuclear power plants production. During uranium milling spill, these radioactive mill waste and acidic radioactive tailings solutions flow into the ocean or river polluting it. Japan's nuclear power plants use uranium hence they are faced with these problems. In addition, workers and people living around nuclear power plants are associated with high risk of having cancer due to

releases during normal process of nuclear power plant. Baker et al, (2007) meta-analysis offered evidence of elevated leukemia rates among children living near 136 nuclear facilities in the United Kingdom, Canada, France, United States, Germany, Japan, and Spain.

Fossil Fuels

Fossil fuels now provide over 91% of Japan's electricity as nuclear plants remain shut down. Consumption of crude and heavy oil for electricity is at a four-year high. The three fossil fuel types are coal, petroleum and natural gas. These are the main resources that supply Japan's energy needs. However, though, these resources have great benefits to the Japan's economy, they also have great environmental effects in Japan. Combustion of fossil fuels releases huge amount of greenhouse gases. It also releases other air pollutants such as nitrogen oxide, sulfur oxide and heavy metals. These greenhouse gases especially carbon dioxide contributes to health problems and global warming which causes the earth temperature to rise. Climate scientists have predicted these greenhouse gases will have more adverse effects if they are not controlled in time, that's why the world now is spending lot of money trying to solve the problem of greenhouse gas emissions, global warming and climate change. Combustion of fossil fuels also generate sulfuric, carbonic, and nitric acids, which fall to earth as acid rain, impacting both natural areas and the built environment. Monuments and sculptures made from marble and limestone are particularly vulnerable, as the acids dissolve calcium carbonate. Coal mining methods and oil refineries also contributes to the air and water pollutions. These gases from burning of coal and also from oil refineries have strong health impacts on people who inhale these gases. These health risks include prem-

ature death, acute respiratory illness, aggravated asthma, chronic bronchitis and decreased lung function. Mining coal can be difficult and dangerous. Strip mining destroys large areas of the landscape.

3.1.2 Renewable Energy Effects on the Environment

Wind power

Harnessing power from the wind is one of the cleanest and most sustainable ways to generate electricity as it produces no toxic pollution or global warming emissions. Wind is also abundant, inexhaustible and affordable, which makes it always available and large-scale alternative to fossil fuels. Despite its vast potential, there are a variety of environmental impacts associated with wind power generation that should be recognized and mitigated.

National Wind Coordinating Committee (NWCC) review of peer-reviewed research found evidence of bird and bat deaths from collisions with wind turbines and due to changes in air pressure caused by the spinning turbines, as well as from habitat disruption. Hence, wind power production sometimes causes life risks to birds and bats. This effect is minimal.

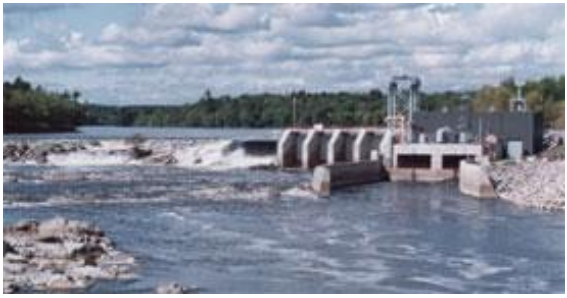
Public health and community effects are another effects of wind power. Sound and visual impact are the two main public health and community concerns associated with operating wind turbines. Some people living close to wind facilities have complained about sound and vibration issues. Wind power turbines are supposed to be developed in areas far away from people, but sometimes, they are sited close to communities and the sound and vibration from the turbines cause discomfort and disturbance to people living around them.

Solar power

Like wind power, the sun provides a tremendous resource for generating clean and sustainable electricity. The effects of solar power includes land use and the use of hazardous materials in manufacturing. The PV cell manufacturing process includes a number of hazardous materials, most of which are used to clean and purify the semiconductor surface. These chemicals, similar to those used in the general semiconductor industry, include hydrochloric acid, sulfuric acid, nitric acid and hydrogen fluoride. These chemicals are sometimes not handled and disposed properly which causes serious environmental or public health issues. Solar energy also has impacts on soil, water and air resources. The construction of solar facilities on vast areas of land imposes clearing and grading, resulting in soil compaction, alteration of drainage channels and increased erosion.

Geothermal energy

The most widely developed type of geothermal power plant (known as hydrothermal plants) are located near geologic "hot spots" where hot molten rock is close to the earth's crust and produces hot water. Geothermal power plants can have impacts on both water quality and consumption. Hot water pumped from underground reservoirs often contains high levels of sulfur, salt, and other minerals. Most geothermal facilities have closed-loop water systems, in which extracted water is pumped directly back into the geothermal reservoir after it has been used for heat or electricity production. In such systems, the water is contained within steel well casings cemented to the surrounding rock. Geothermal energy production which includes drawing fluids from the earth core leads to greenhouse gases emissions. Greenhouse gases such as hydrogen sulfide, CO2, methane and boron are emitted into the atmosphere with geothermal energy leading to global warming and climate change, though it contribution to global warming is minimal. Geothermal fluids contain elevated levels of certain toxic elements such as arsenic, mercury, lithium and boron, these toxic chemicals if not properly disposed well and it flows into water causes water pollution and affect the lives of aquatic animals. Constructing a geothermal power plant requires deep drilling which can affect the stability of the land and at times can even trigger earthquakes.



Hydroelectric power

Hydroelectric power includes both massive hydroelectric dams and small run-of-the-river plants. Hydroelectric power has wildlife impacts. Hydroelectric facilities can still have a major impact on aquatic ecosystems. For example, though there are a variety of methods to minimize the impact (including fish ladders and in-take screens), fish and other organisms can be injured and killed by turbine blades. Operating a hydroelectric power plant may also change the water temperature and the river's flow. These changes may harm native plants and animals in the river and on land. Methane, a strong greenhouse gas, may also form in some reservoirs and be emitted to the atmosphere.

From the explanation above, both renewable and non-renewable energy have impacts on the environment, however, the impacts of non-renewable energy on

the environment are more critical and serious than renewable energy. These above mentioned effects of energy on environment are major issues facing the Japanese energy sector as well as the world at large. With Japan dependency on non-renewable energy, which highly emit greenhouse gases, these above effects are severe in the country.

4. Conclusion and Recommendations

This paper has examined the impact of energy resources on Japan's environment over the period from 2000 to 2014. The findings showed that, CO2 and energy consumption have positive relationship and energy is a major contributor to greenhouse gas emission in Japan, due to Japan's dependency on non-renewable energy resources which have greater impacts on the environment. The findings also showed that energy created from renewable resources are safe, clean, simple, reliable and environment friendly much more than energy created from non-renewable resources. Producing renewable energy with proper care causes negligible damage to environment and is certainly from the environmental perspective one of the best clean energy options. This natural source of energy provides efficient way to harness energy with minimal impact on its surrounding environment, therefore, in order for Japan to reduce environmental effects of energy, the country needs to drastically reduce its dependence on non-renewable energy and increase production of renewable energy. To sum it up, energy efficiency and renewable energy are said to be the twin pillars of sustainable energy policy and are high priorities in the sustainable energy hierarchy, hence, the Japanese government needs to implement these policies to ensure clean and sustainable energy.

References

1. Böhringer, C., and Löschel, A. (2006), "Promoting Renewable Energy in Europe: A
2. Hybrid Computable General Equilibrium Approach". The Energy Journal, Hybrid
3. Modelling, special issue, 135-150.
4. Hayashi, Y. (2014), "Energy Situation in Japan-Japan's New Energy Strategy", Counsellor, Embassy of Japan in Germany, pp. 4-13.
5. Bozkurt, I. (2010), "Energy Resources and Their Effects on Environment", WSEAS Transactions on Environment and Development, vol. 6
6. Union of Concerned Scientists, (2015) "Environmental Impacts of Renewable Energy Technologies",http://www.ucsusa.org/clean-energy/renewable-energy/environmental-impacts#.WCW1hi197IX
7. Dizdarevic, N.V. and Zikovic S. (2010) "The Role of Energy in Economic Growth: The Case of Croatia", Zb. rad. Ekon. fak. Rij. • vol. 28 • sv. 1 • 35-60.

8. Ayres, R.U., van den Bergh, J.C.J.M. (2005) "A theory of economic growth with material/energy resources and dematerialization: Interaction of three growth mechanisms", Econologal Economics, 55, pp.96-118.
9. Acemoglu, D., Johnson, S. and Robinson, J.A. (2001) "The Colonial Origins of Comparative Development: An Empirical Investigation", The American Economic Review, 91(5), pp.1369-401.
10. Acemoglu, D., Johnson, S. and Robinson, J.A. (2002) "Reversal of Fortune: Geography and Institutions in the Making of the Modern Income Distribution", The Quarterly Journal of Econometrics, 118, pp.1231-94.
11. International Energy Agency, (2016) "Japan: Balances for 2005-2014", http://www.iea.org/statistics/statisticssearch/report/?year=2014&country=JAPAN&product=Balances
12. The World Bank, (2016) "World Development Indicators", http://databank.worldbank.org/data/reports.aspx?source=2&series=SL.TLF.TOTL.IN&country=JPN
13. Economic Research Federal Reserve Bank of St. Louis, (2016) "Bank of Japan: Total Asset of Japan", https://fred.stlouisfed.org/series/JPNASSETS